

Chapter 05

Lecture Outline*

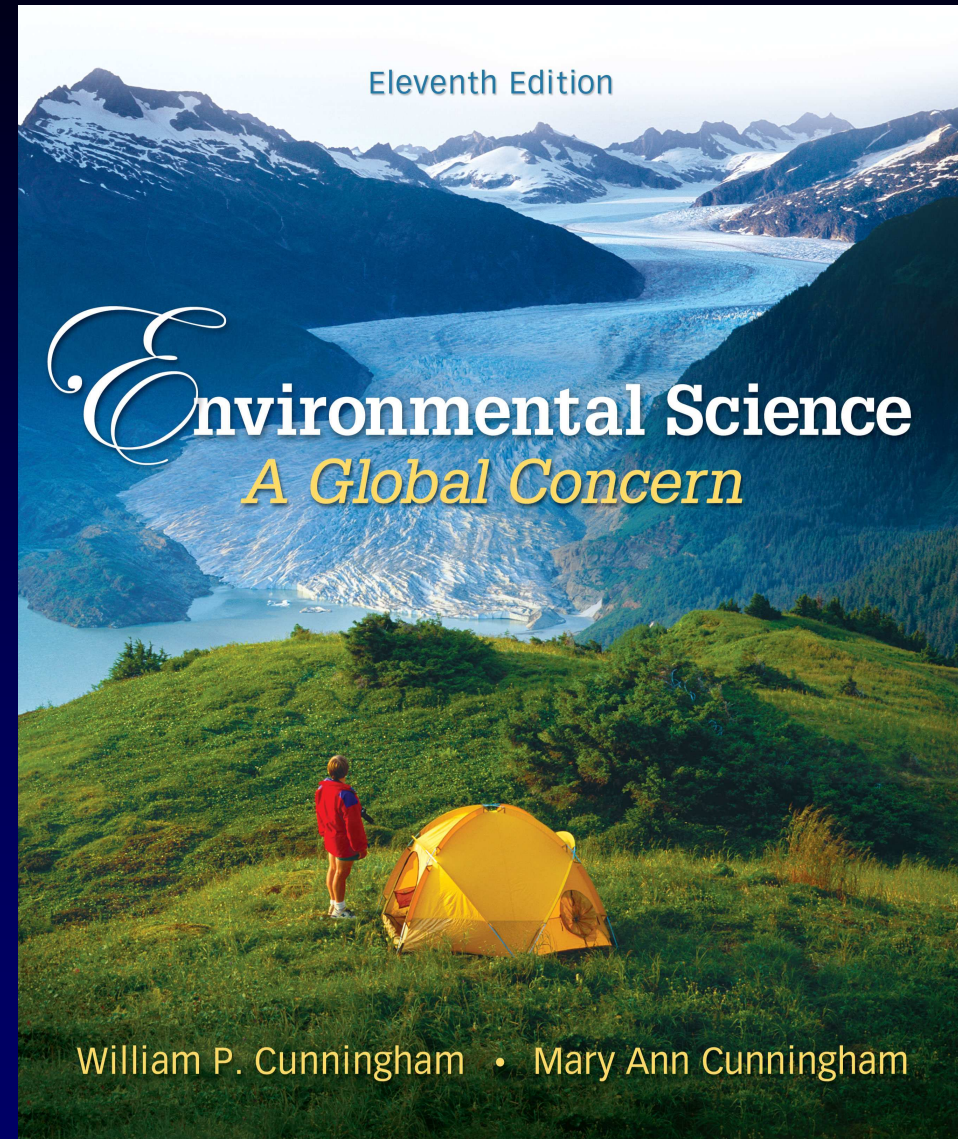
William P. Cunningham

University of Minnesota

Mary Ann Cunningham

Vassar College

***See PowerPoint Image Slides for all
figures and tables pre-inserted into
PowerPoint without notes.**



Biomes: Global Patterns of Life

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



© William P. Cunningham

Outline

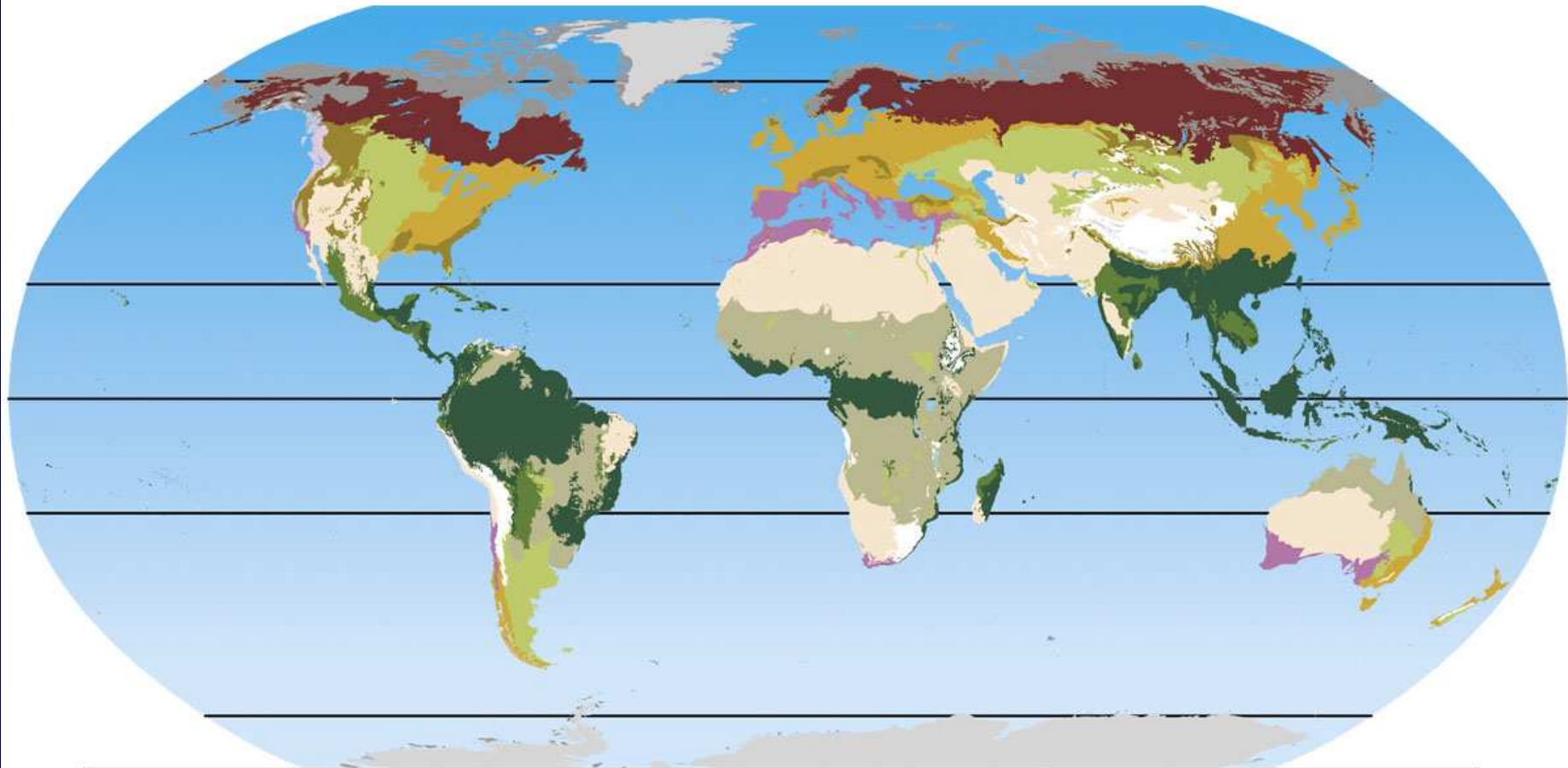
- Terrestrial Biomes
- Marine Ecosystems
 - ❖ Open Ocean
 - ❖ Shallow Coasts
- Freshwater Ecosystems
 - ❖ Lakes
 - ❖ Wetlands
- Human Disturbance

Terrestrial Biomes

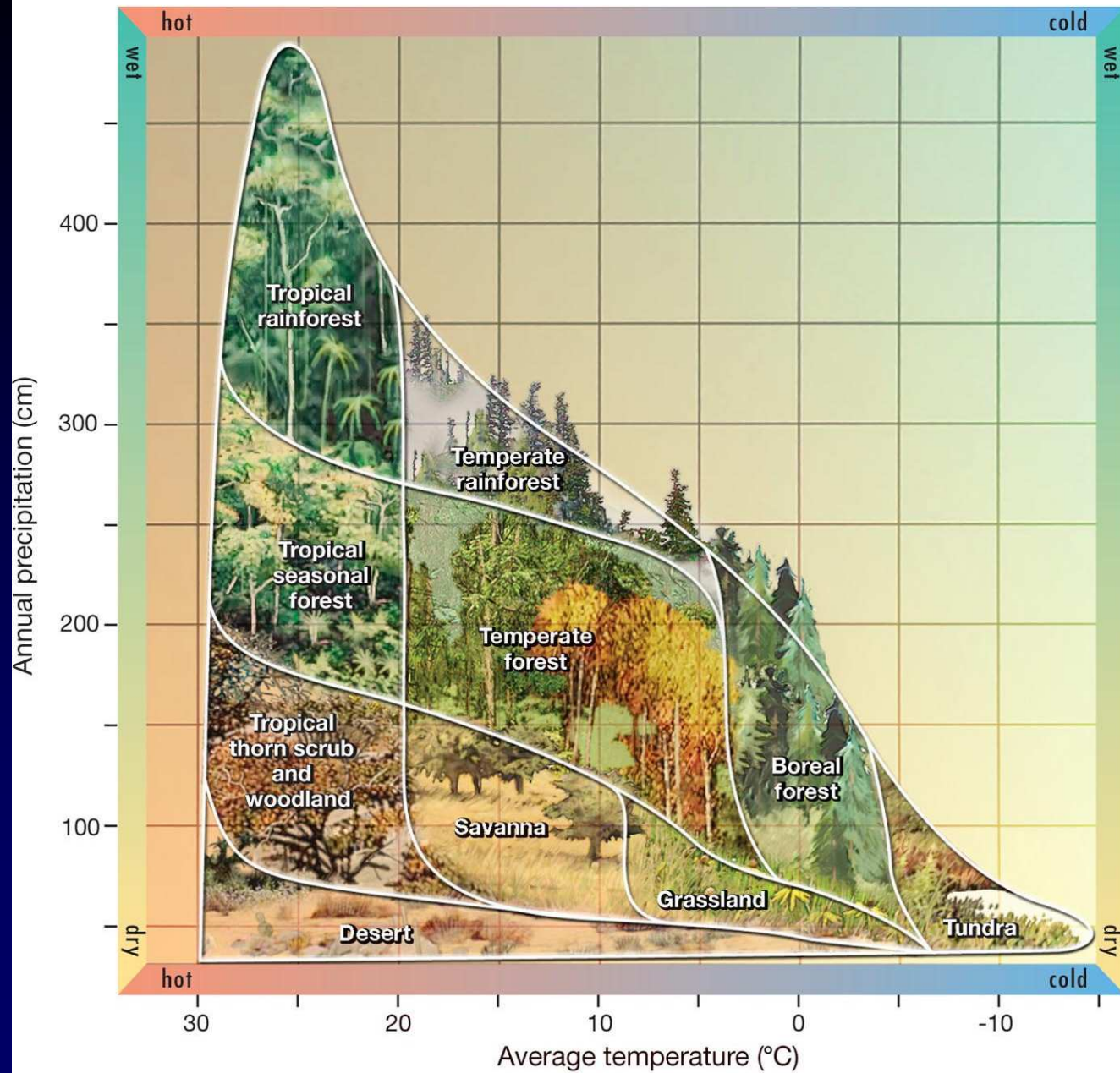
- **Biomes** - areas sharing similar climate, topographic and soil conditions, and thus the same basic types of biological communities.
- Temperature and precipitation are among the most important determinants in biome distribution.
 - ❖ Many temperature-controlled biomes occur in latitudinal bands.

Biomes

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

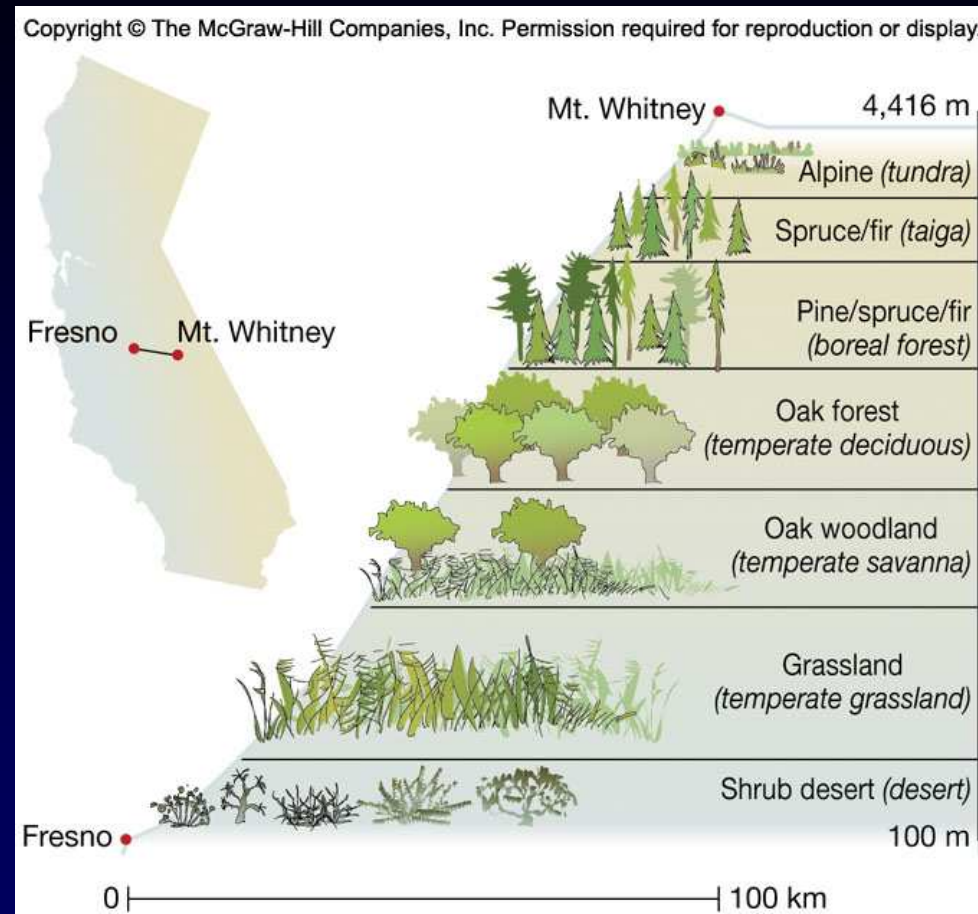


- | | | |
|---|---------------------------------------|-----------------------------------|
| Tropical rainforest, subtropical moist forest | Temperate rainforest | Boreal forests |
| Tropical and subtropical seasonal forests | Temperate conifer forests | Tundra |
| Tropical grasslands and savannas | Temperate broadleaf and mixed forests | Rock and ice |
| Deserts and dry shrublands | Mediterranean woodlands and scrub | Montane grasslands and shrublands |
| | Temperate grasslands and savannas | |



From COMMUNITIES AND ECOSYSTEMS, 2nd Edition by Robert C. Whittaker. Copyright © 1975.
Reprinted by permission of Pearson Education, Inc., Upper Saddle River, NJ

Biomes



- Temperature and precipitation also change with altitude. As you go up a mountain, it gets cooler and wetter. **Vertical zonation** is a term applied to vegetation zones defined by altitude.

Rainforests

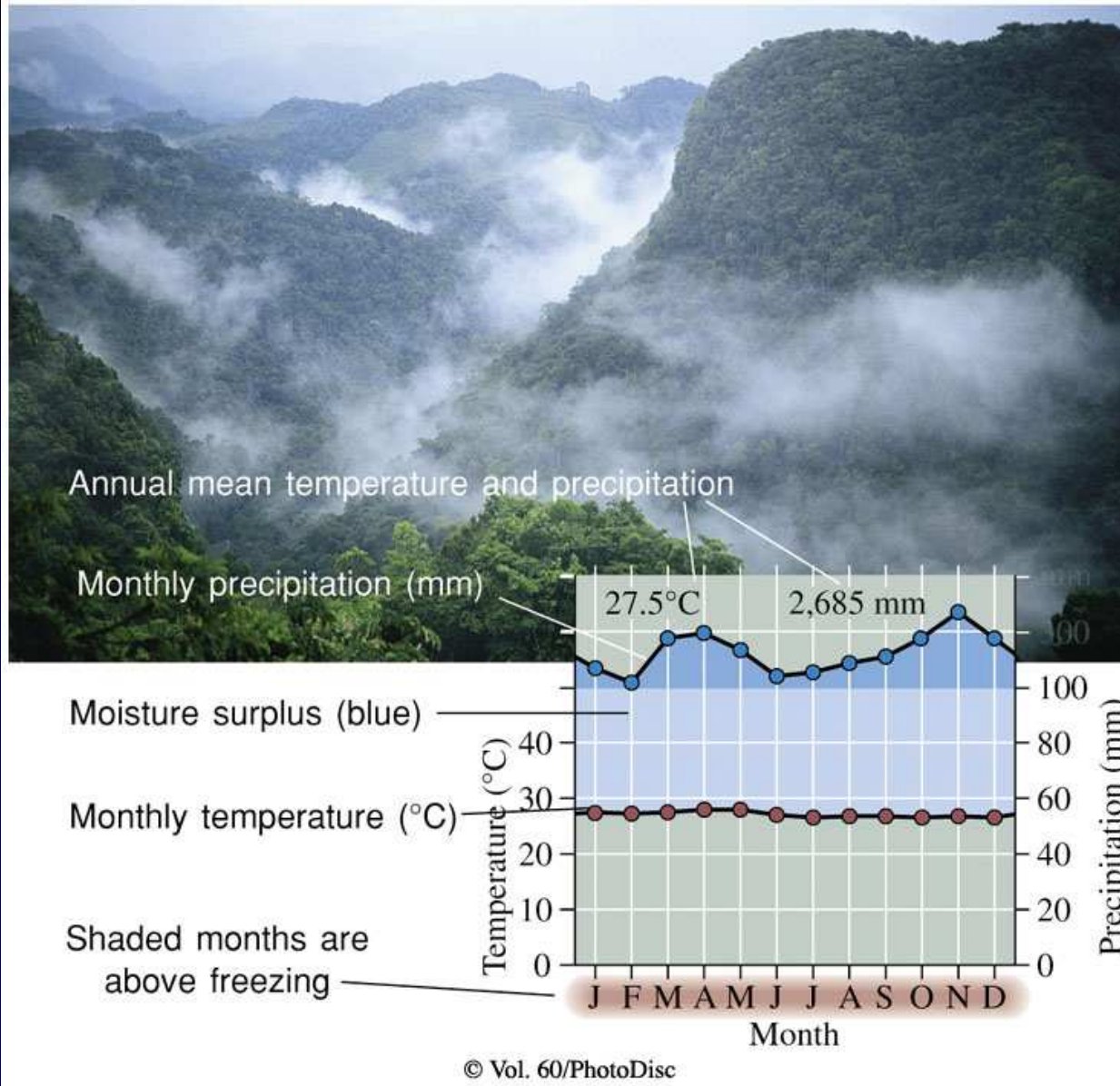
- Humid tropical regions support one of the most complex and biologically rich biomes.
- Ample rainfall and uniform temperatures
 - ❖ **Cloud Forests** - high mountains where fog and mist keep vegetation continually wet
 - ❖ **Tropical rainforests** - occur where rainfall exceeds 200 cm (80 inches) per year and temperatures are warm to hot year round

Rainforests

- Soil in rainforests tends to be thin and nutrient poor.
 - ❖ 90% nutrients tied up in living organisms
 - ❖ Rapid decomposition and nutrient cycling
 - ❖ Thin soil cannot support continued cropping and cannot resist erosion.
 - ❖ Rapid deforestation occurring as people move into the forests
- One half to two thirds of all the species of terrestrial plants and animals live in tropical forests.

Tropical Rainforests

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



Tropical Seasonal Forests

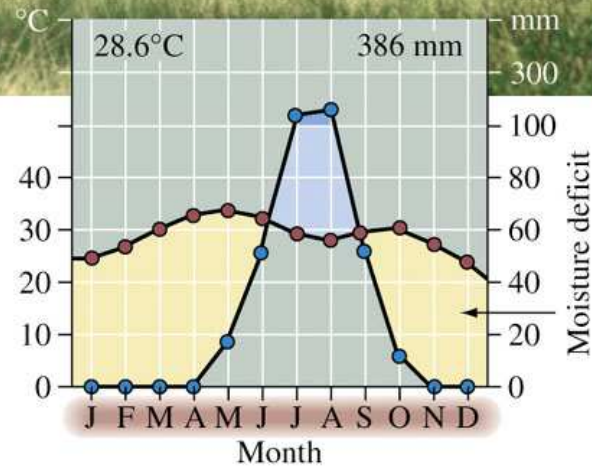
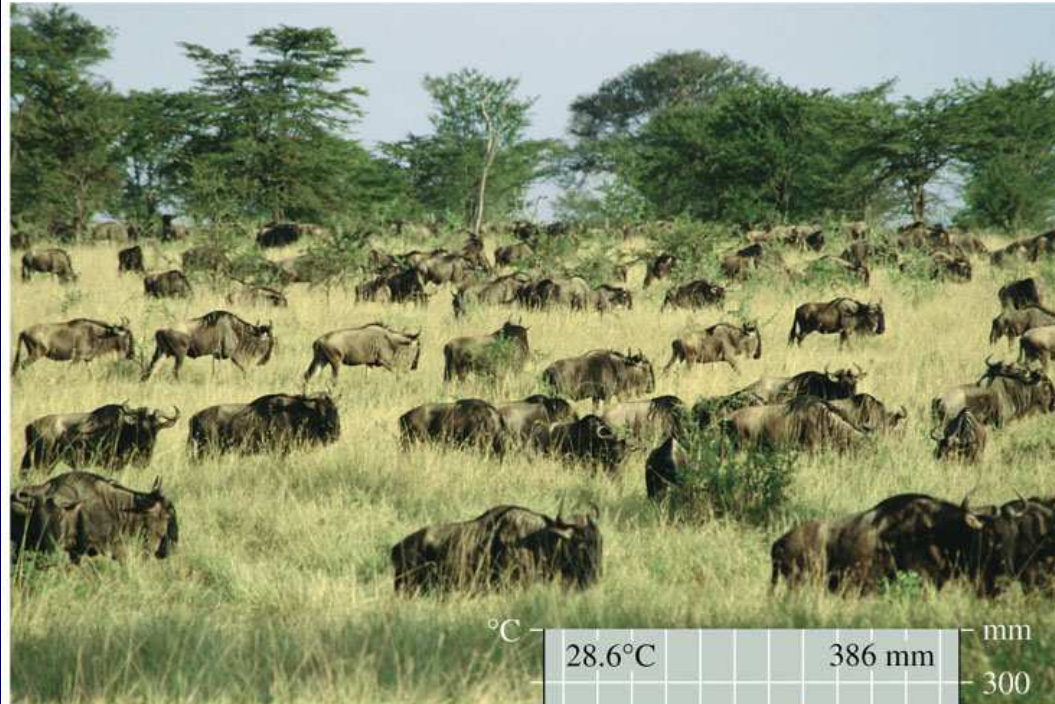
- Many tropical regions are characterized by wet and dry seasons with hot temperatures year round. These support **tropical seasonal forests**.
- Dry and brown much of the year but become green during the rainy season
- Many of the plants are drought deciduous; they lose their leaves when it is dry.
- Few of the tropical seasonal forests remain in their natural state as humans use fire to clear the land in the dry season and settle there.

Tropical Savannas and Grasslands

- Grasslands with sparse tree cover are called savannas.
- Too little rainfall to support forests
- Dry season prone to fire
- Plants with deep, long-lived roots and other adaptations to survive drought, heat, and fire
- Many migratory grazers such as antelope, wildebeest, or bison

Tropical Savannas and Grasslands

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



© Vol. 6/Corbis

Deserts

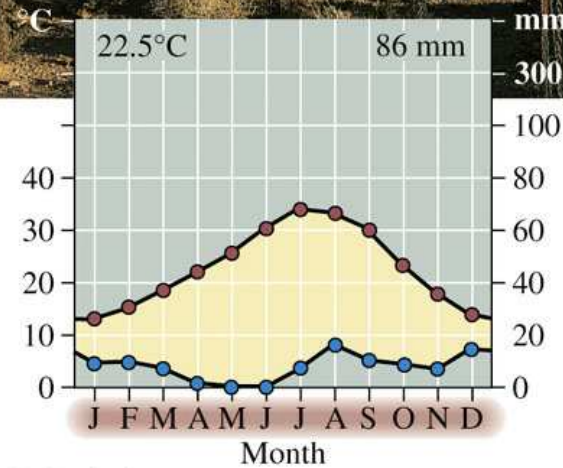
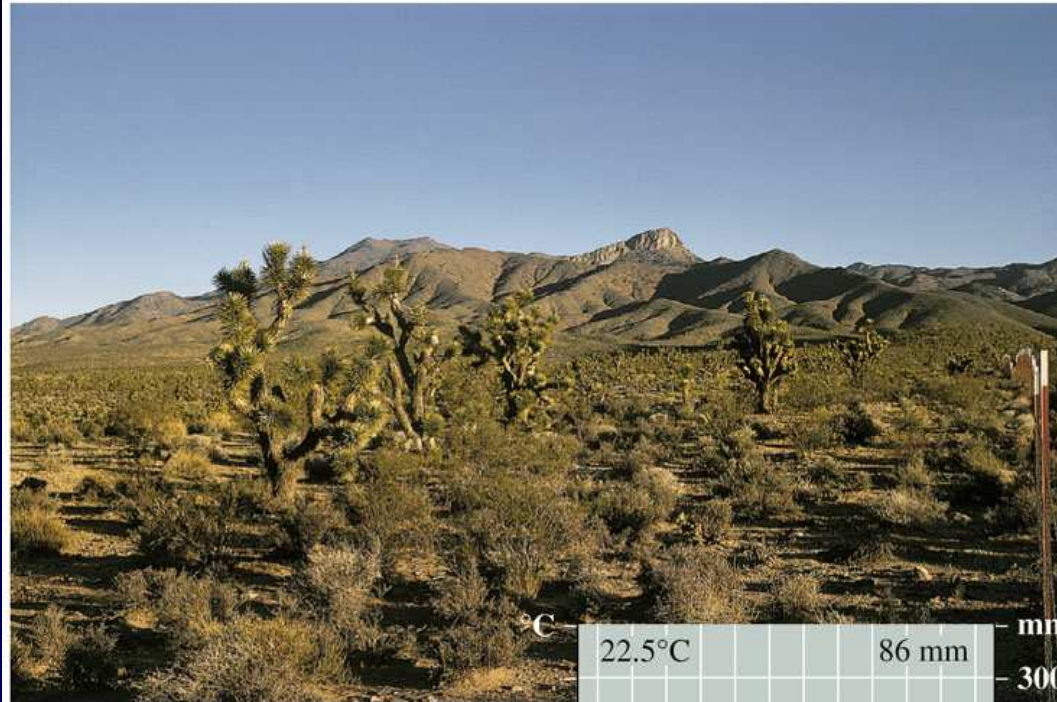
- Characterized by low moisture levels (less than 30 cm per year) and precipitation that is infrequent and unpredictable from year to year. Deserts have wide daily and seasonal temperature fluctuations.
- Plants exhibit water conservation characteristics such as water-storing stems, thick epidermis to reduce water loss, and salt tolerance.

Deserts

- Animals also have adaptations. Many are nocturnal and able to conserve water.
- Deserts are vulnerable.
 - ❖ Slow growing vegetation is damaged by off road vehicles. It takes decades for desert soils to recover.
 - ❖ Overgrazing - Livestock are destroying the plants of the southern Sahara. Without plants the land cannot retain what little rainfall there is and it becomes more barren.

Deserts

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



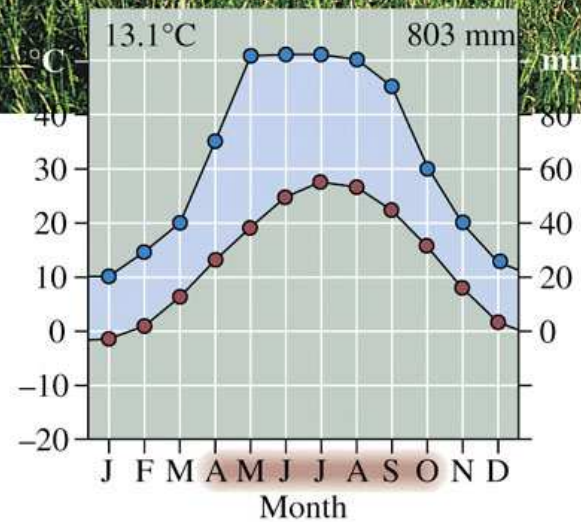
© William P. Cunningham

Temperate Grasslands

- Communities of grasses and seasonal herbaceous flowering plants
- Few trees due to inadequate rainfall
- Large daily and seasonal temperature fluctuations
- Thick organic soils
- Much converted to farmland. The prairies in the U.S. are now farms.
- Overgrazing is a threat because it kills the plants and permits erosion to occur.

Grasslands

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



© Mary Ann Cunningham

Mediterranean or Temperate Shrubland

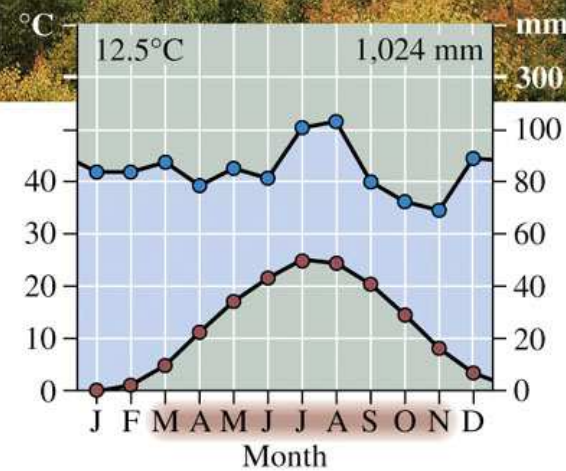
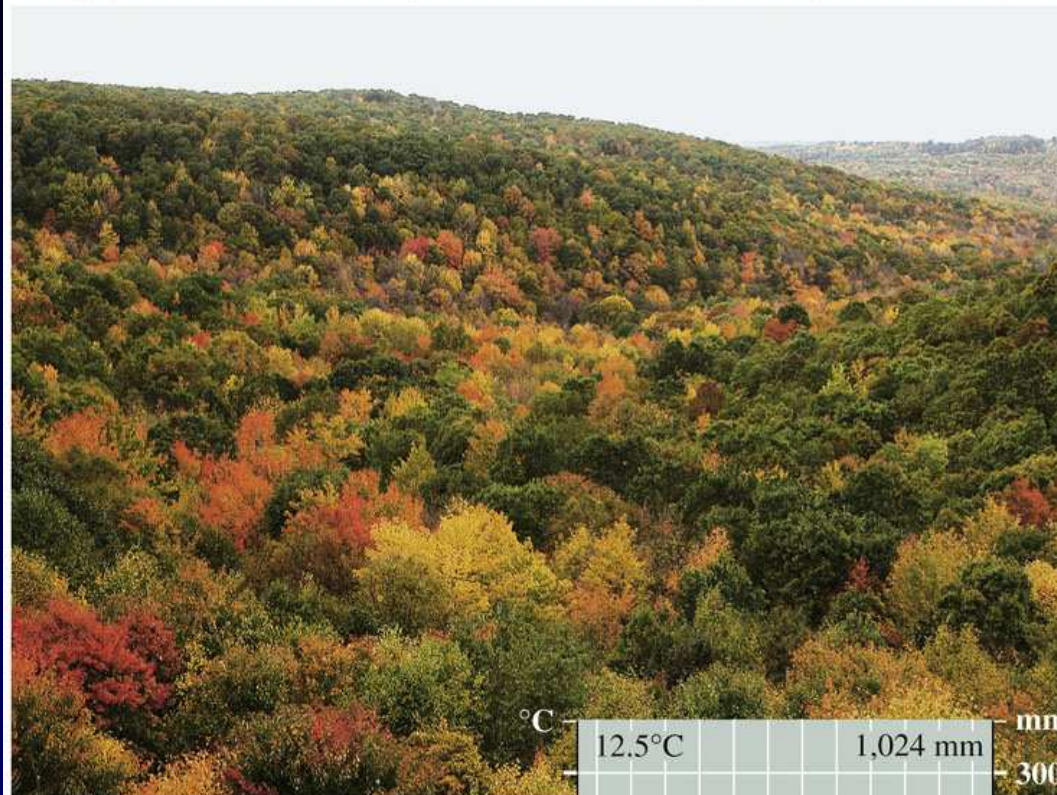
- Characterized by warm, dry summers and cool, moist winters
- Evergreen shrubs, scrub oaks, pines
- Fires are a major factor in plant succession.
 - ❖ Referred to as **chaparral** in California
 - High biodiversity
 - Human homes built in chaparral harm endangered wildlife and burn periodically.
 - ❖ Also found along Mediterranean coast, southwestern Australia, Chile and South Africa

Deciduous Forest

- Temperate regions support lush summer plant growth when water is plentiful.
 - ❖ Deciduous trees lose their leaves in winter as an adaptation to freezing temperatures.
- Eastern half of U.S. was covered with broad leaf deciduous forest when European settlers arrived. Much of that was harvested for timber.
 - ❖ Areas in U.S. have re-grown, although the dominant species are different
 - ❖ Areas in Siberia severely threatened now

Temperate Deciduous Forests

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



© William P. Cunningham

Temperate Coniferous Forests

- Often occur where moisture is limited
- Plants reduce water loss by evolving thin, needle-like evergreen leaves with thick waxy coating.
 - ❖ Can survive harsh winters or extended droughts and accomplish photosynthesis even under poor conditions
- Source of most wood products in North America

Coniferous Forests

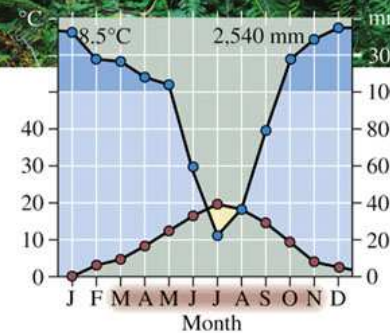
- **Temperate rainforest** - wet, foggy forests of the Pacific coast. Up to 250 cm (100 inches) of rain per year.
 - ❖ Mild temperatures year-round
 - ❖ Redwood forests fall into this category.
 - ❖ Conservation battle to save the remnants of these old growth forests
- **Boreal Forest** - Northern Coniferous Forest
 - ❖ Broad band of mixed coniferous and deciduous trees between 50° and 60°N latitude
 - ❖ Dominated by pines, hemlock, spruce, cedar and fir with some deciduous trees mixed in

Boreal Forests

- **Taiga** - Northernmost edge of boreal forest
 - ❖ Species-poor. Harsh climate limits productivity and resilience.
 - ❖ Extreme cold and short summers limit the growth rate of trees. A tree that is 4 inches (10 cm) in diameter may be over 200 years old.

Temperate Rainforest

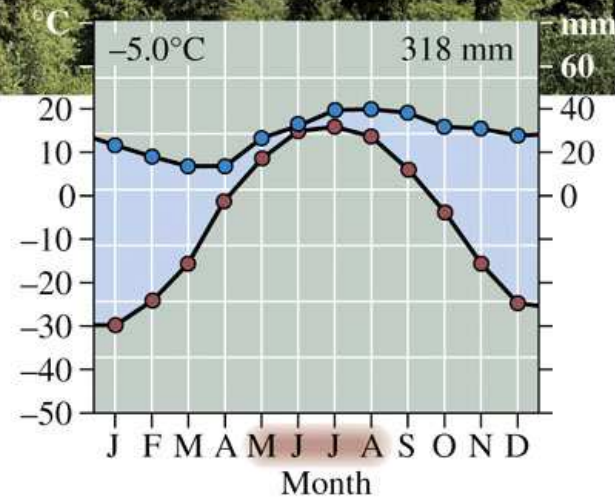
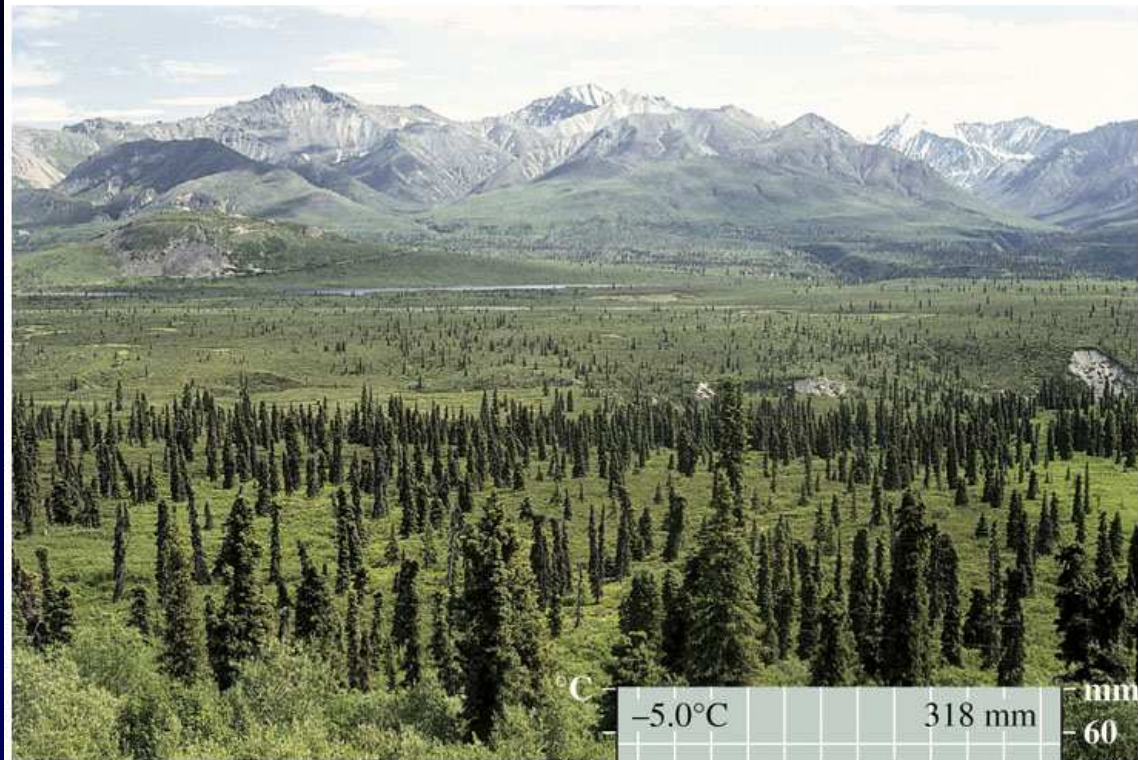
Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



© Vol. 90/Corbis

Boreal Forest

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



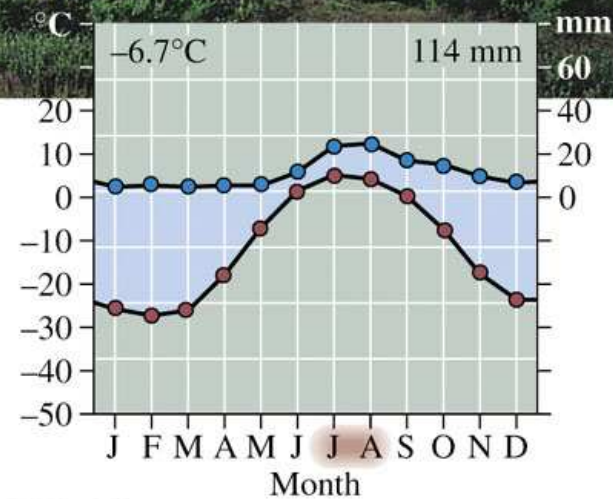
© William P. Cunningham

Tundra

- Treeless
- Two to three month growing season, with cold harsh winters
 - ❖ **Arctic Tundra** exhibits low productivity, but during midsummer supports migratory birds by the millions.
 - ❖ **Alpine Tundra** occurs on or near mountaintops
 - Vegetation similar to arctic tundra
 - Relatively low biodiversity
 - Threatened by global warming and oil drilling in Alaska and Siberia

Tundra

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

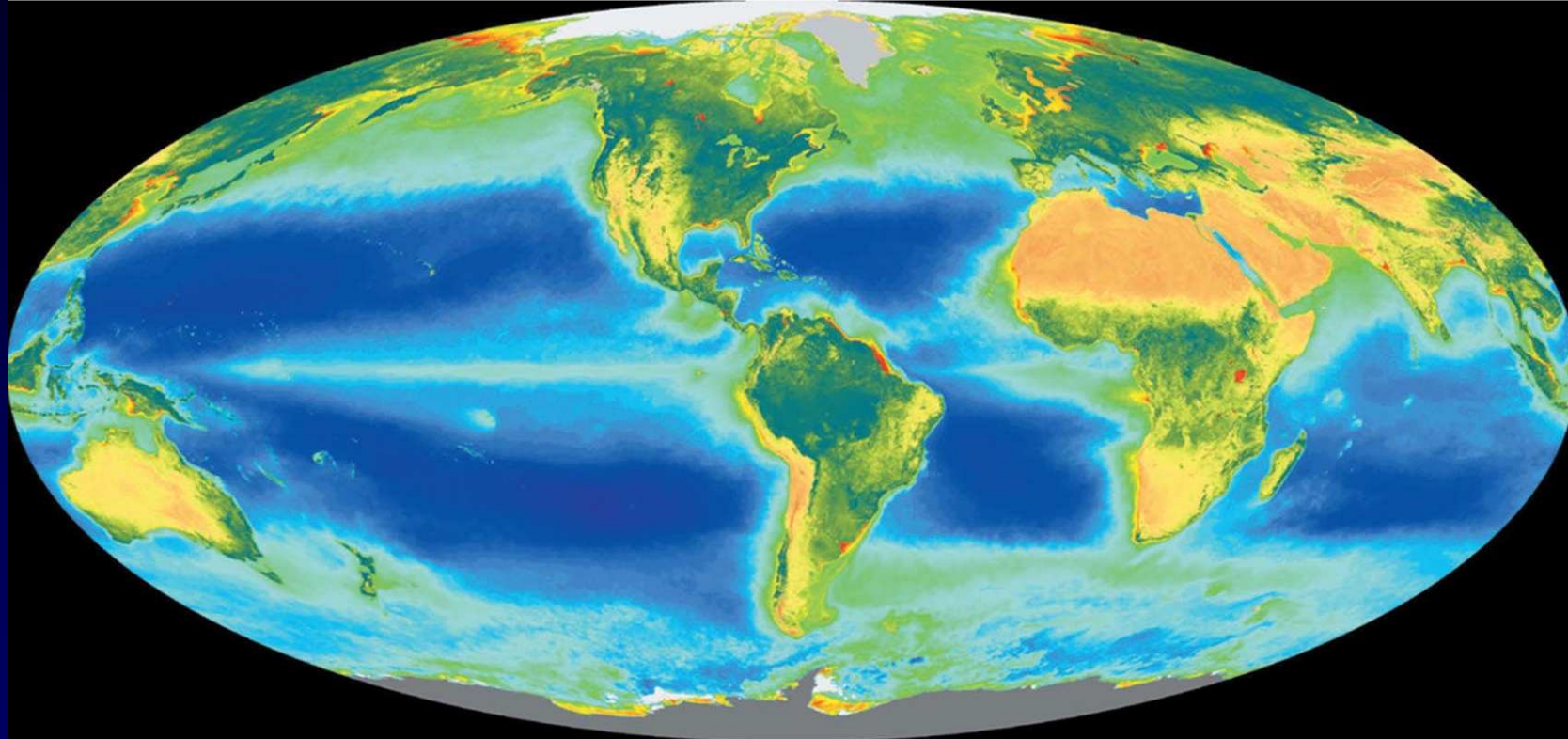


Vol. 74/PhotoDisc

Marine Ecosystems

- Oceans cover 3/4 of Earth's surface.
- Photosynthesis is carried out by algae or free floating plants (phytoplankton). Greatest amount of photosynthesis near the coast where nutrients wash in.
- Organisms die and fall to sea floor where the nutrients are used in deep ocean ecosystems.
- Upwelling currents circulate nutrients from the ocean floor back to the surface.

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



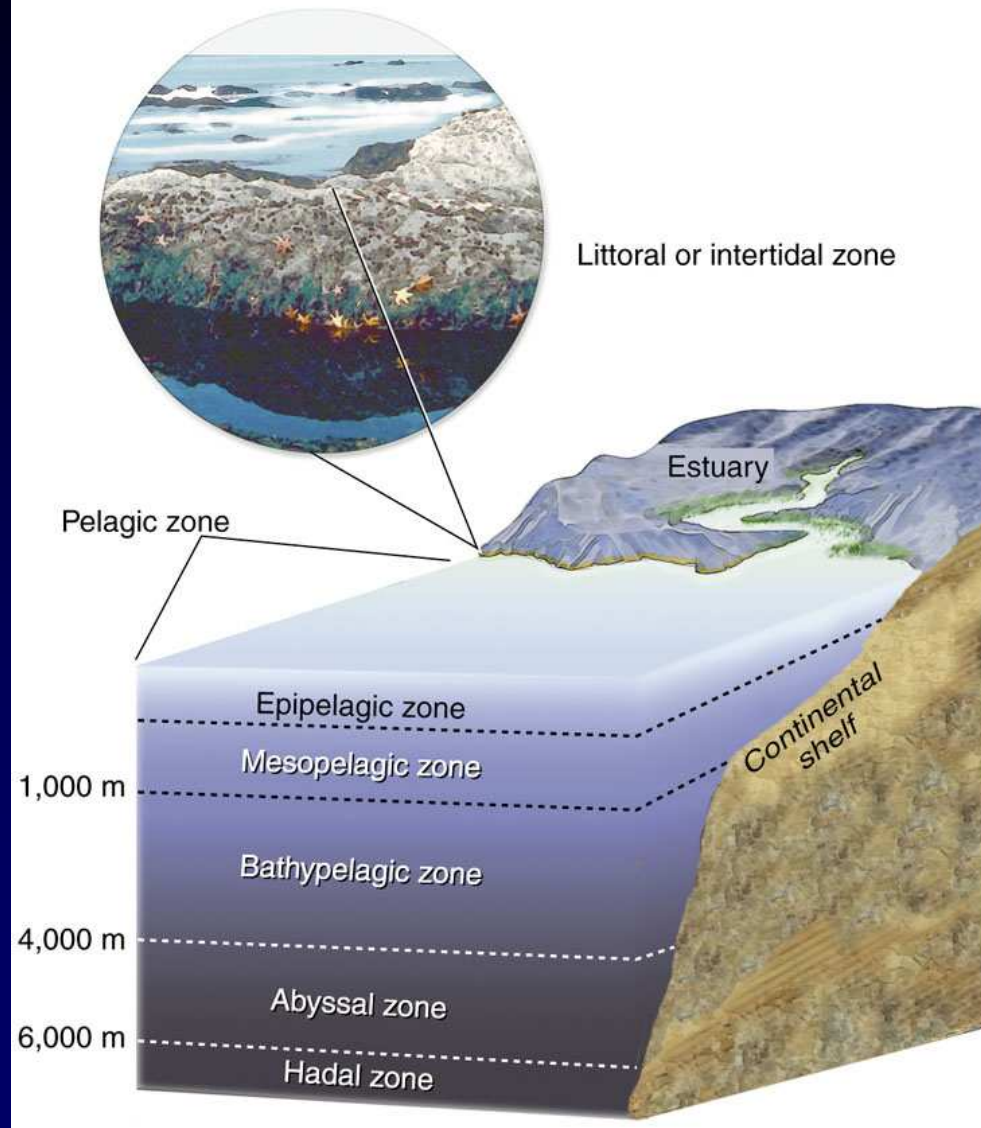
Courtesy of SeaWiFS/NASA

Marine Ecosystems

- Vertical stratification is a key feature.
 - ❖ Light and temperature decrease with depth and deep ocean species often grow slowly.
 - ❖ Cold water holds more oxygen than warm water so productivity is often high in cold oceans such as the North Atlantic.
- Ocean systems classified:
 - ❖ **Benthic** - bottom
 - ❖ **Pelagic** - water column above the bottom
- Area near shore is known as **littoral zone**

Zones of the Ocean

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



Surface to Hadal Zone Communities

- Open ocean is a biological desert except for areas where nutrients are distributed by currents e.g. Sargasso Sea in the Atlantic
- The deepest layer of the ocean (hadal zone) contains communities of tube worms, mussels, etc. supported by microbes that capture chemical energy from thermal vents on the ocean floor. These organisms are adapted to extreme temperatures (700 degrees F) and intense pressure.

Thermal Vent Community

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



NOAA

Coastal Zones

- Communities vary with depth, light, temperature and nutrient concentration.
- **Coral Reefs** - Aggregations of coral polyps that live symbiotically with algae. Their calcium rich skeletons build up the reef.
 - ❖ Light must penetrate for algal photosynthesis.
 - ❖ Threatened by trash, sewage, urban runoff, industrial waste, introduced pathogens and global warming. Global warming causes **coral bleaching** in which corals expel their algal partners and then die.
 - ❖ One third of coral reefs have already been destroyed and 60% of the remaining reefs will probably be dead by 2030 (2006 UNESCO Conference).

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



© Vol. 89/PhotoDisc/Getty RF

Mangroves

- Mangroves are trees that grow in saltwater along tropical coastlines.
- Help stabilize shoreline
- Nurseries for fish, shrimp
- Can be cut for timber

Tidal Environments

- **Estuaries** - bays or semi-enclosed bodies of brackish water that form where rivers enter the ocean
- **Salt marshes** - coastal wetlands flooded regularly or occasionally by seawater
 - ❖ Both are nutrient rich and biologically diverse.
 - ❖ 2/3 of marine fish and shellfish rely on estuaries for spawning and development.



Tide Pools

- Depressions in a rocky shoreline that are flooded at high tide but retain some water at low tide
- Wave action prevents plant growth, but animals can be found in tidal pools.

Barrier Islands

- Narrow islands made of sand that form parallel to a coastline
- Provide protection from storms, waves, tides
- Since they are made of sand, they should not be built on, but they are. Oftentimes, storms destroy the buildings.



Storm Erosion on a Barrier Island

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



© Stephen Rose

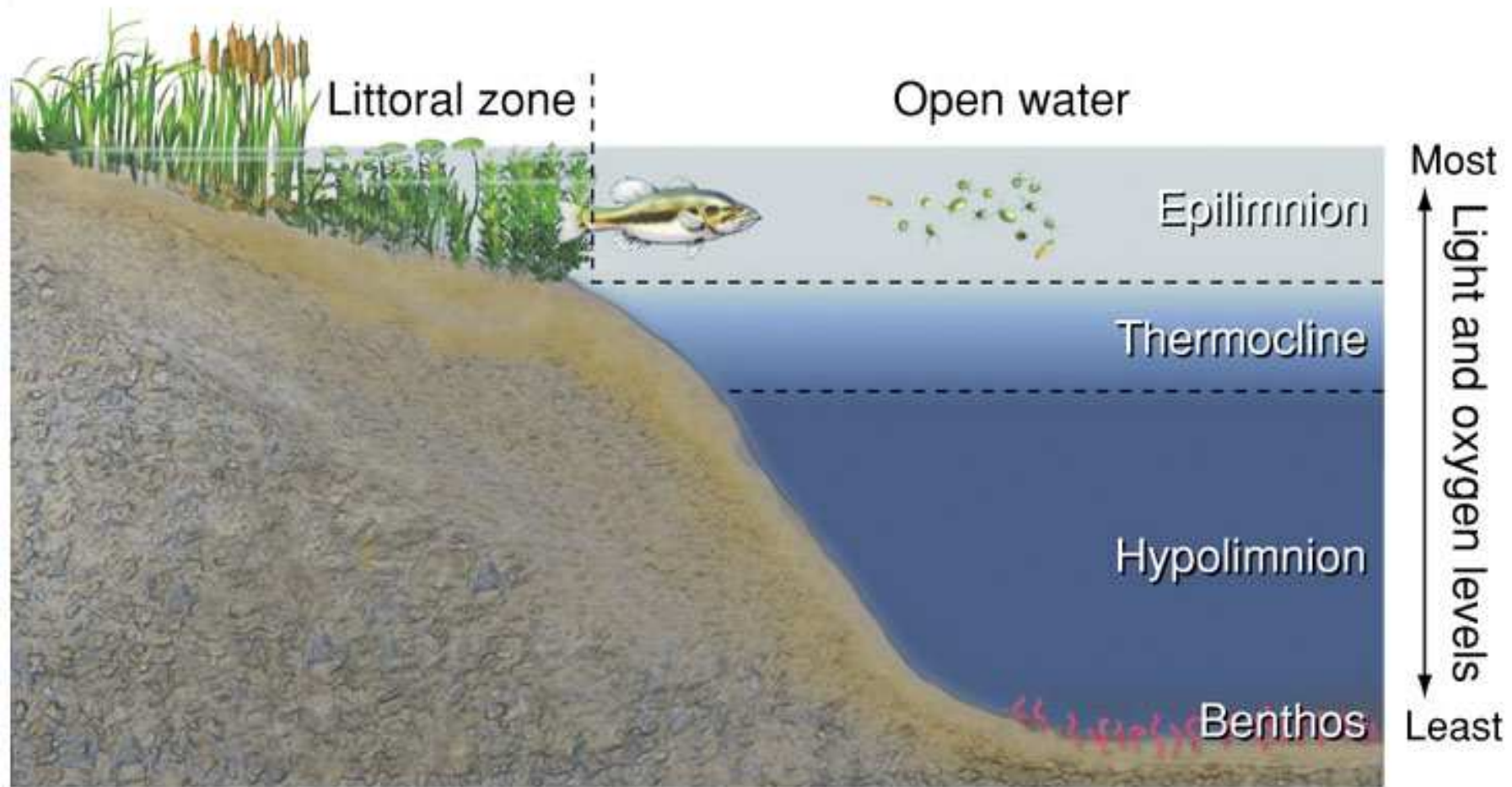
Freshwater Ecosystems

- Lakes

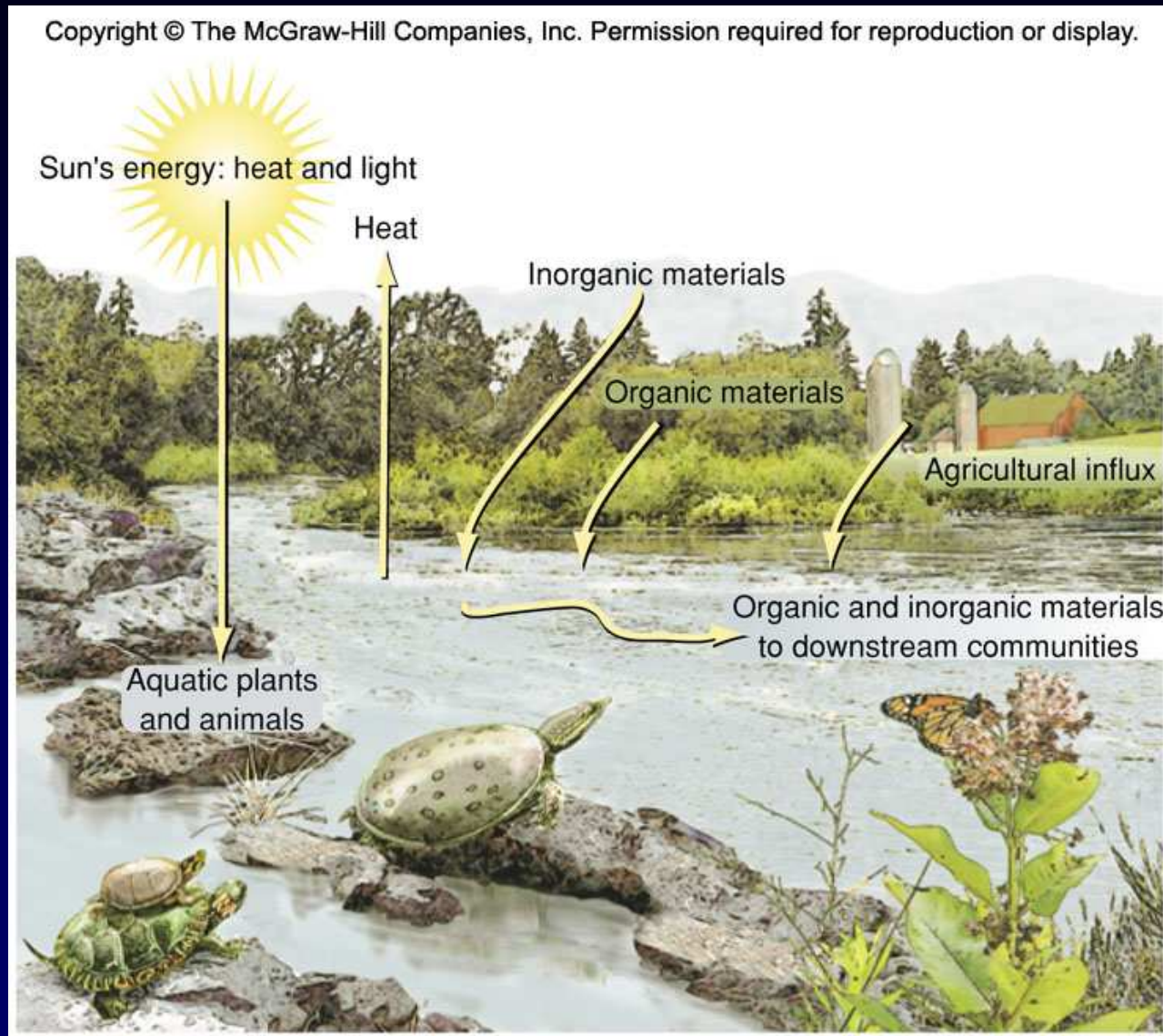
- ❖ Freshwater lakes have distinct vertical zones.
 - Epilimnion - warm upper layer
 - Hypolimnion - cold, deeper layer that does not mix
 - **Thermocline** - distinctive temperature transition zone that separates warm upper layer and deeper cold layer
 - Benthos - bottom

Layers of a Lake

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



Terrestrial Ecosystems Influence a Lake



Wetlands

- Land surface is saturated or covered with water at least part of the year.
 - ❖ **Swamps** - Wetlands with trees.
 - ❖ **Marshes** - Wetlands without trees.
 - ❖ **Bogs and Fens** - Waterlogged soils that tend to accumulate peat. Bogs fed by precipitation, while fens are fed from groundwater. Nutrient poor with low productivity, but many unusual species.
- Water usually shallow enough to allow full sunlight penetration, so the majority of wetlands have high productivity.
- Trap and filter water, and store runoff.

Wetlands

- Conservation is very important due to rich biodiversity. Wetlands are the breeding grounds for birds. Make up less than 5% of land area, but contain 33% of endangered species. One of the greatest areas of concern for biologists.
- May gradually convert to terrestrial communities through succession

Wetlands

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



(a) Swamp, or wooded wetland

© Vol. 16/PhotoDisc



(b) Marsh

© Vol. 16/PhotoDisc



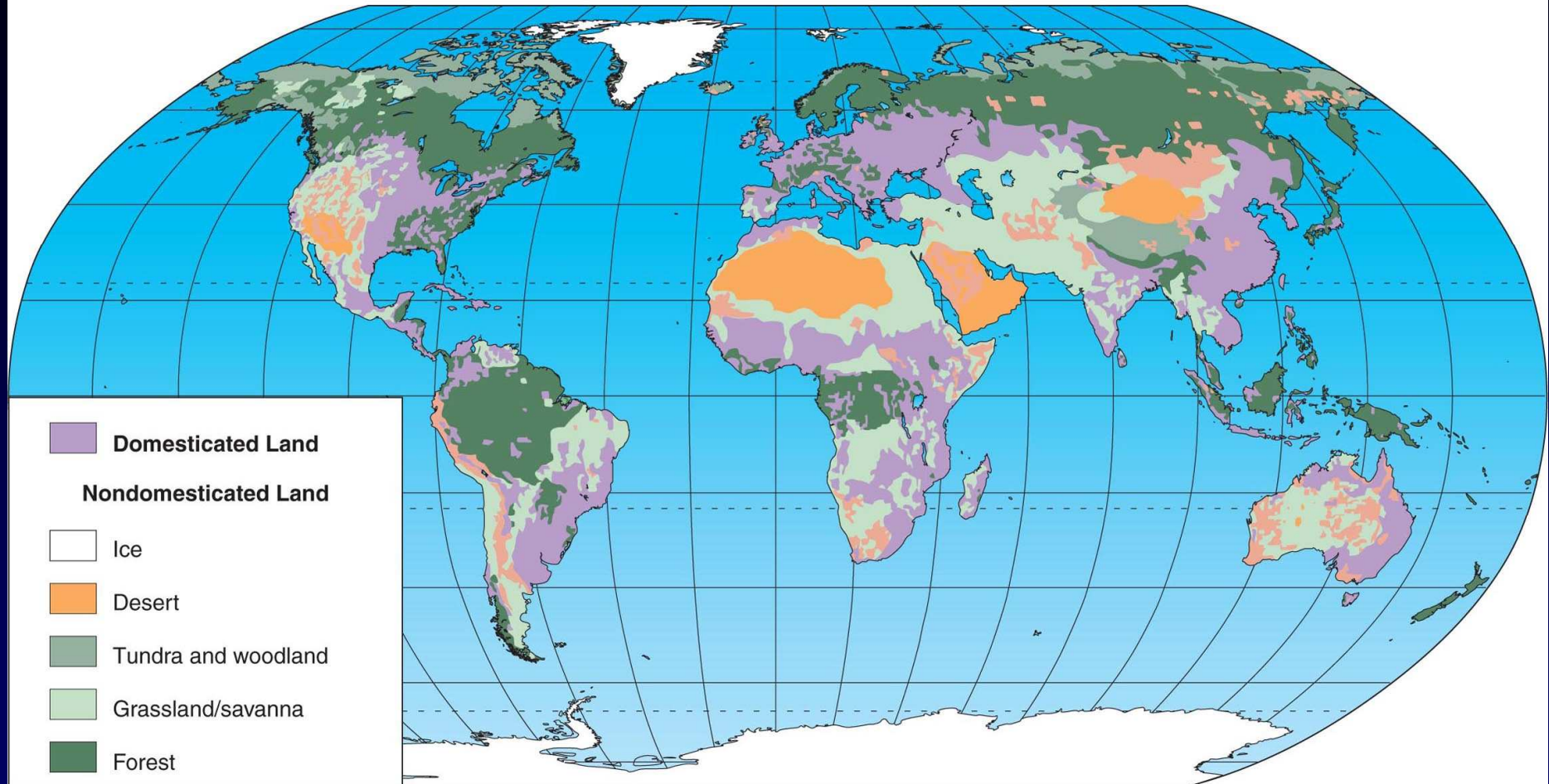
(c) Coastal saltmarsh

© William P. Cunningham

Human Disturbance

- By some estimates, humans preempt about 40% of net terrestrial primary productivity.
- Conversion of habitat to human use is single largest cause of biodiversity loss.
- Temperate deciduous forests are the most completely human-dominated biome. Tundra and Arctic Deserts are the least disturbed.
- About half of all original wetlands in the U.S. have been degraded over the past 250 years.

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



Human Disturbance

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

TABLE 5.1

Human Disturbance

Biome	Total Area (10 ⁶ km ²)	% Undisturbed Habitat	% Human Dominated
Temperate broad-leaf forests	9.5	6.1	81.9
Chaparral	6.6	6.4	67.8
Temperate grasslands	12.1	27.6	40.4
Temperate rainforests	4.2	33.0	46.1
Tropical dry forests	19.5	30.5	45.9
Mixed mountain systems	12.1	29.3	25.6
Mixed island systems	3.2	46.6	41.8
Cold deserts/semideserts	10.9	45.4	8.5
Warm deserts/semideserts	29.2	55.8	12.2
Moist tropical forests	11.8	63.2	24.9
Tropical grasslands	4.8	74.0	4.7
Temperate coniferous forests	18.8	81.7	11.8
Tundra and arctic desert	20.6	99.3	0.3

Note: Where undisturbed and human-dominated areas do not add up to 100 percent, the difference represents partially disturbed lands.

Source: Hannah, Lee, et al., "Human Disturbance and Natural Habitat: A Biome Level Analysis of a Global Data Set," in *Biodiversity and Conservation*, 1995, Vol. 4:128–55.